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OHIO RIVER POLLUTION SURVEY

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MODERN SEWAGE AND INDUSTRIAL
WASTES TREATMENT PLANT
AT
DURHAM, NORTH CAROLINA

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INDUSTRIAL WASTES AND THE OHIO RIVER POLLUTION SURVEY

A Symposium

The Ohio River Pollution Survey has a number of field engineers who have been working on industrial wastes for various periods up to a maximum of nearly two years. Several of these men have been invited to contribute to this Activities Bulletin and it is believed that the contributions which follow will be of considerable general interest. A contribution from Messrs. Harrington and Watson of the State of West Virginia is used as the first of these discussions on industrial wastes.

Recent Stream Pollution Surveys in West Virginia

J. B. Harrington, Director
Division of Sanitary Engineering
West Virginia Department of Health
and
K. S. Watson, Chemical Engineer
West Virginia Water Commission

We should like to point out as we see them the purposes of the Ohio River Pollution Survey and the manner in which this survey is being conducted in this state. Aside from the fact-finding survey which has progressed satisfactorily in West Virginia, we were fortunate to have assigned to our State one of the special trailer laboratories for a period of approximately three months to make special investigations. The United States Public Health Service furnished three technicians and the State Department of Health supplemented this crew with three engineers to make surveys of the lower sections of the Kanawha and Elk Rivers where industrial wastes have been of great detriment to water supplies and fish life. Another joint project sponsored by the Federal and State agencies is the Monongahela River basin survey which is nearing completion.

Elk River Survey

The Elk River Survey was undertaken to determine the source, nature and extent of a river taste and odor causing water treatment difficulties at the Charleston water plant. The survey was carried out between December 7, 1939, and

January 29, 1940, and covered a section of the river extending from the Queen Shoals Bridge to the mouth of the stream, a distance of twenty-five miles. During this period 403 samples were analyzed, chiefly for the cold and hot threshold odors.

Two odor areas were found in the Elk River and three industries were established as responsible for these odor sections. A report covering the river findings was prepared, containing recommendations to the effect that the three plants segregate all of their direct contact wastes and either recirculate these wastes or treat them before discharging these effluents into the river. The State anticipates the cooperation of these industries in removing much of the objectionable odor from the river.

Kanawha River Survey

The purpose and procedure of making the Kanawha River Survey were very similar to those of the Elk River. Taste and odor-bearing effluents released by the industrial plants in the Charleston area have been responsible for operating difficulties at the water treatment plants at Saint Albans, Nitro, Winfield and Huntington. The survey was also undertaken to determine more about the effect of the sewage from Charleston and from the South Charleston industrial area upon the river. This survey was carried out between January 29, 1940, and March 15, 1940, and covered a section of the river extending from the Chelyan Bridge to the Winfield Locks, a distance of fifty-two miles. The same survey personnel who made the Elk River Survey also made the Kanawha River Survey.

Chemical, biochemical, bacteriological and odor analyses were made in carrying this survey through. In addition to nine river points, each of which was sampled nine times, forty-four industrial effluents from the South Charleston industrial area were sampled many times during this period.

The survey findings served to identify the downstream odor and to demonstrate the fact that most of it came from the South Charleston industrial area. Additional work indicated that the odors from two separate areas of one of the South Charleston plants were apparently combining in the river to cause much of the downstream odor.

A report covering the survey findings was sent to each of the offending industries and recommendations were contained therein to the effect that these plants attack their odor problems by removing the odor from the worst effluents first. The plants have agreed to work on their problems from this angle

and have under construction at the present time remedial systems which will keep the worst discharges out of the stream. One of the units is scheduled to go into operation about December 1, and the river will be carefully studied just before and just after this installation.

Upper Monongahela River Survey

Both the State Department of Health and the United States Public Health Service planned to make a survey of the Monongahela River in the spring of 1940. To prevent duplication of effort the basin was divided into two sections and each agency made a survey of the section assigned to it. Chemical, biochemical, and bacteriological analyses, using a standardized procedure, were made in carrying out this survey. The work was carried out between the middle of May and the first of July. After the analytical work had been completed the two agencies exchanged data so that each agency had an analytical picture of the upper basin.

Conclusion

In the past decade several partial surveys have been made of wastes discharged from the industries in the Charleston industrial area; however, through a lack of personnel, the results of these surveys did not enable the State Department of Health to place before the officials of the industries sufficient accurate information to justify that corrective steps be taken. During the recent comprehensive survey the company officials cooperated to the fullest extent, and since the reports were forwarded to them they have indicated that every effort will be made to comply with the recommendations.

Our observations of recent months indicate that the industrial heads of West Virginia are becoming considerably more pollution conscious due to the extensive Ohio River Survey and that many of them, feeling that the correction of their pollution problems is the inevitable, are now assigning personnel from their own pay rolls to solve their problems.

The benefits resulting from the state-wide survey by the United States Public Health Service will be many, and aside from the objectionable pollution which will be eliminated, the information which is being accumulated and made available to the State will be of lasting assistance to the State engineers.

The Magnitude of Some Industrial Wastes in the Tennessee River Watershed

R. F. Poston,
Asst. Public Health Engineer,

Twelve industrial plants, on which sampling and gaging studies have been made by the T.V.A. and the Ohio River Pollution Survey since May 1939, discharge a total of 106 m.g.d. of industrial waste and have an aggregate population equivalent (based on B.O.D.) of 392,000. One plant studied has installed equipment to recover a valuable by-product and subsequently improve conditions in the stream. At another plant a conscientious effort is being made to remove all suspended organic material from the waste so that the stream will not become grossly polluted. These two instances are the only attempts made by these industries to treat their wastes. Practically all of the waste is discharged through private outlets direct to the streams, and in nearly all cases it would be impractical to combine industrial wastes with domestic sewage for treatment.

The above plants included textile, chemical, leather, paper and miscellaneous establishments. One plant has a discharge of 3.0 m.g.d. and a population equivalent of 132,000; another plant discharges 85 m.g.d. with a population equivalent of 124,000; another making a special paper discharges 8.0 m.g.d. of waste with a population equivalent of 49,500. This last plant is now undertaking an expansion program which will double its capacity. At a plant not listed above, industrial wastes averaging 10.8 m.g.d. are being discharged. These wastes are acid in nature and are treated with limestone so that the methyl orange acidity is nearly zero. This requires up to 1100 tons of limestone per month. No effort is made to keep the resultant sludge from the river. Samples taken from the river show that 182 tons of suspended solids are discharged daily. One industrial plant's waste discolors the receiving stream to inky blackness for a distance of over sixty miles and has at times seriously affected the water supply of a large city 140 miles downstream.

The instances cited cover most, though not all, of the types of larger industries in the Tennessee Basin. About 200 of the thousand or more industries are discharging waste to the streams and less than a fraction of one per cent of these make any effort to treat their wastes.

The attitude of industry seems to be one of cooperation. If the industries are given the proper incentive a comprehensive pollution abatement program could be carried out. Any such

program should include the advisory services of some technical governmental agency who can advise satisfactory methods of treatment for the various wastes. Some of the unique plants in this area will require considerable research and experimental work before treatment plants may be designed and installed.

Acid Mine Drainage

Paul D. Haney
Asst. Sanitary Engineer (R)

Mine drainage containing sulphuric acid and the acid salts (sulfates) of iron and aluminum from active and abandoned coal mines in the bituminous coal mining areas in Pennsylvania, West Virginia, Ohio, Maryland, Kentucky, Indiana, Illinois and Virginia is one of the most important industrial wastes found in the Ohio River Basin. The pollution problem resulting from the entry of acid mine drainage into the surface streams is greatest in the upper third of the basin where the most important North American bituminous coal producing areas are located.

The effect of acid mine water on small and large streams is to: (1) destroy or materially reduce alkalinity, thus converting carbonate to non-carbonate hardness; (2) lower the pH; (3) increase the total hardness (mine water often contains considerable calcium and magnesium); and (4) add what may in some instances, be objectionable amounts of iron, manganese and sulfate.

These effects all influence normal water use. Thus the water may, by acid pollution, be rendered (1) expensive and difficult to treat for municipal or industrial use, (2) unfit for recreational use, (3) unfit for aquatic life, (4) highly corrosive to all but the most resistant structural materials (valves, pumps, locks, dams, piers, culverts may be affected).

The biological characteristics of a moderately to heavily acid polluted stream are substantially altered. Plankton and bacteria are materially reduced and their normal activities inhibited. Sewage solids are deposited, especially at low flows, forming sludge banks. This occurs under normal conditions but in the case of streams receiving mine drainage this action is favored by the precipitating action of the iron and aluminum hydroxides which are derived from the hydrolysis of the corresponding sulphates. The attainment of scouring velocities in the stream may resuspend these sludge deposits, carrying them to an alkaline zone where their normal oxygen demand will be exerted.

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The treatment of water subject to pollution by acid mine drainage may not be difficult in all cases but is likely to be expensive if the acid salt content is high. Mine waste polluted waters often contain enough iron and aluminum so that excellent coagulation may be obtained by the use of lime alone. An important consideration, however, is the likelihood of wide variation in the raw water quality under conditions of acid pollution. Due to day-to-day variations in mine pumping and gravity drainage there may be, especially in small streams, a substantial and rapid fluctuation in acidity, bacteria and coagulation characteristics. This requires unusually careful plant operating control.

Remedial Measures

The acid and acid salt content of mine drainage results from the action of water in the presence of air (oxygen) on pyrite and marcasite minerals, having the composition, FeS_2, which are commonly associated with coal deposits. The products of such oxidation are sulfuric acid and iron sulfate.

Research work at the U. S. Bureau of Mines has demonstrated that oxygen is essential for the acid production reaction and that its removal or reduction stops or materially reduces acid formation. This has been confirmed by actual field experience during the past several years by large scale mine sealing work carried on through the cooperation of the U. S. Public Health Service, various state health departments and Federal relief agencies. Sealing work involves two important steps (1) the filling of surface cracks and caves, (2) the construction of barrier walls equipped with water seals at the drainage points. Use of water seals does not result in appreciable impoundment of drainage but effectively prevents the entry of air into the mine. The net result of such sealing is reduction of oxygen in the mine air and reduction of the surface runoff entering the mine.

Measured in terms of actual acid reduction on mines sealed, sealing measures are from 50 to about 75% efficient.

Industrial Wastes

G. E. McCallum
Asst. Public Health Engineer

It is a recognized fact that the industrial waste problem has received far less attention than has pollution resulting from domestic sewage. When it is realized that a large amount of the corrective work accomplished has resulted from the action of public agencies whose primary reason for existence has been the protection and preservation of public health, this method of approach to the pollution problem is understandable.

Aside from a few specific diseases such as anthrax which may be present in wastes from tanneries, abattoirs and rendering plants, industrial wastes do not as a rule carry disease producing bacteria and consequently, have not usually been considered a direct menace to public health. It is true that industrial wastes do occasionally contain toxic substances which may directly affect public health, but more often their effect is of an indirect nature. For instance, the production of disagreeable odors, the interference with natural purification processes of streams, the destruction of the value of a stream for recreational or agricultural purposes, and the destruction of fish and other aquatic life do not appear to directly involve the public health. However, through the channels of discomfort and inconvenience they may have an indirect effect upon general welfare and public health. Since public health officials are becoming more concerned over these indirect effects upon the health and welfare of the people, they are giving this type of pollution more serious thought.

The industrial waste problem appears to be coming into prominence not only because of increased industrial activity and a greater emphasis on the recreational values of streams, but also in somewhat the same way as whooping cough recently became to be considered important as a childhood disease. The seriousness of this disease was not fully realized until immunization and improved methods of control so reduced the incidence of more important diseases that whooping cough then remained as a prominent cause of infant mortality. The more rapid progress in the treatment of domestic sewage is likewise causing the industrial waste problem to occupy a position of greater significance.

A review of certain authoritative opinions which have been presented over the past few years regarding industrial waste pollution is of interest. Quoting from a special report "Stream Pollution in Wisconsin" published by the Wisconsin State Board of Health in 1927 - "The greatest danger to the public health

is from domestic sewage because of the disease germs that this waste carries. - - - "Pollution from industrial wastes, therefore, does not, as a rule, constitute a serious menace to public health unless it is such as to interfere with the normal process of purification when the water is used as a public supply".

The 1933-1934 Biennial Report of the Michigan Stream Control Commission states - "Industrial waste pollution, while secondary to sewage pollution from the standpoint of public health, is often more destructive of surface water values. - - - "Less is known about corrective measures than about the more standardized sewage treatment practice. Research agencies cooperating with the commission are often compelled to point the way. With the cooperation of industry these problems can be solved". The following statement from this same report emphasizes the sympathetic attitude and good judgment which the commission exercised toward industry and the general public during the years preceding 1933-1934:- "The economic condition of industry has barred general capital outlays necessary to correction - the necessity of fostering employment at almost any cost has been the prevailing public policy". The 1937-1938 Biennial Report of the same body states - "Progress in the control of industrial pollution continues to advance but is not keeping pace with that made in the municipal field. Some of the reasons encountered are worth noting. Federal aid for the correction of such problems is not available to industry, of course, as it has been to municipalities. Where substantial capital outlay is required to establish control, progress appears to be retarded as the result of uncertainties growing out of labor, economic and production readjustments."

This same report, published by an agency with years of successful experience in water pollution control in a large industrial state and one which has admittedly learned through trial and error further asserts - "The commission seeks to enlist insofar as possible the cooperation of industries which cause objectionable wastes in solving their problems. Past court injunctions and legal processes, in general, have not advanced the cause of pollution control unless accompanied by known feasible methods and means of securing correction. - - - Education and conversion of industry to the policy of so operating as to eliminate detrimental pollution is necessary".

Those who are acquainted with the activities of other water pollution control agencies know that this same policy prevails in other industrial states, and the viewpoint of education and cooperation is without a doubt shared by all who have had any experience in the control of industrial waste pollution. The above named report mentions the possibility of internal changes in manufacturing processes, the development of by-products, and the salvage of materials formerly discharged with the waste water as possibilities in reducing or eliminating

present water pollution. These three possibilities, singly, or in combination may often be accomplished without causing great expense to the industry. In this way the cost of industrial treatment may be considerably reduced. In some cases such changes may reduce the strength and volume of wastes to the extent that they can be admitted to a municipal sewage treatment plant or natural water course without injurious effects. It appears that industry usually requires some stimulating influence to demonstrate the possibilities existing relative to such corrective measures. This leadership can probably best be supplied by the public agency charged with water pollution control. F. W. Mohlman of the Chicago Sanitary District states that those who have conducted industrial waste surveys find that industry is rarely aware of the value of the products which are going down the sewer until a reliable sampling and gaging survey is conducted in cooperation with some public engineering agency.

There are numerous instances in which the public health official working in cooperation with industry has abated stream pollution and at the same time effected savings in raw materials and/or the economical recovery of valuable by-products. In addition to these actual savings, the cost of treatment of wastes along with the cost of court proceedings and the possibility of damage payments resulting therefrom, have often been eliminated.

An outstanding example of the discovery of losses unknown to industry occurred at Battle Creek, Michigan, when the municipal sewage treatment plant was placed in operation. Grain from food manufacturing industries was received at the plant in quantities that seriously interfered with operations and also presented an acute problem in the handling and disposal of the grain. Industrial officials had to be brought to the sewage treatment plant to be convinced of the conditions. Upon visiting the plant these officials were amazed at the quantity of grain and expressed deep concern. This resulted in a prompt survey of the industries, correction of certain defective equipment and methods, and the annual saving of many thousands of dollars.

There has been some remarkable work done along this line by many public agencies in the past few years but unfortunately and for obvious reasons much of it cannot be published. This approach in which the public official offers industry a valuable consulting service and asks only cooperation in return is obtaining results and at the same time building confidence and good will.

The industrial executive is eager and willing to cooperate in the abatement of stream pollution when it can be demonstrated that by so doing there exists a possibility of effecting savings in operating expense. On the other hand, he is hesitant and most likely to procrastinate when required to make capital expenditures merely to provide another riparian user with water of

unimpaired quality. This executive may have never thought of a stream as having any other valuable use than that of a vehicle for carrying industrial wastes. The industrial executive, the public health official, the conservationist, the farmer, and the water treatment plant operator, along with others have a widely divergent concept as to the proper use of a stream. Drainage basin meetings, as promoted by the National Resources Planning Commission, serve a most useful purpose in bringing together all of these different groups with their varied interests. As a result of these meetings each group is given the opportunity of presenting its own opinions and what is more important becoming aware of the interests of the other groups involved. The fostering of this spirit of cooperation and tolerance is an encouraging and important movement with respect to stream usage.

When industry, facing a serious pollution problem, begins calling upon its state health department or other pollution control agency instead of its legal staff - and this is actually happening today - we are rapidly approaching the type of team work which cannot fail in the ultimate solution of this problem.

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PROGRESS REPORT ON SOURCES OF POLLUTION

Peak production in the number of field survey reports completed on sources of pollution was reached during September-October, 1940. Reports covering 1121 industries and communities were received by the Cincinnati office during this period. All eleven sub-stations were active and the grand total was made up of 784 reports on water supply and sewerage and 337 reports on industries.

The following table gives a summary, by watersheds, of the progress attained in investigating sources of pollution:

Watershed	Miles to Mouth	Industries Completed			Communities Completed		
		Sept. Oct.	To-date Reports	Per cent Complete	Sept. Oct.	To-date Reports	Per cent Complete
Allegheny	981	91	108	48	163	208	70
Beaver	956	11	61	17	10	15	22
Big Sandy	664	0	3	100	0	149	100
Cumberland	61	5	88	100	0	199	100
Green	197	6	13	100	2	84	95
Guyandot	676	0	2	100	0	107	100
Hocking	782	4	5	100	4	30	100
Kanawha	715	0	67	100	0	254	100
Kentucky	435	0	40	100	0	85	100
Licking	511	0	18	100	0	46	100
L. Kanawha	796	0	3	100	0	17	100
L. Miami	517	0	11	100	0	52	100
Miami	490	0	119	100	0	129	100
Monongahela	981	47	64	74	219	318	88
Muskingum	809	22	85	86	33	151	98
Scioto	625	0	55	100	0	103	100
Salt	351	1	28	100	0	26	95
Tennessee	47	7	233	100	141	148	41
Wabash	133	94	176	50	114	274	50
Ohio (M&D)	-	49	161	36	98	266	64
1939 Total		-	553	-	-	984	-
1940 Total		-	787	-	-	1677	-
TOTAL		337	1340	67	784	2661	81

SUMMARY OF LABORATORY OPERATIONS FOR SEPTEMBER AND OCTOBER

Laboratory operations were carried forward during this two-month period, with the greatest production reached at any time during the entire survey.

This was due to the fact that the Cincinnati Laboratory, the six trailer units, the motor boats and the "Kiski" were all in operation. The "Kiski" had moved upstream from Marietta to East Liverpool, Ohio, on September 23, 1940. The new sampling schedule for the Pittsburgh-Wheeling section of the river was immediately placed in operation with sampling stations at each main dam.

The number of water samples examined to date by all laboratory facilities and the determinations made are indicated in the table below. By the end of October, 1940, the total number of determinations was slightly over 100,000.

Summary - Combined Laboratory Operations
August - September - October, 1940

	To Aug.31	To Sept.30	To Oct.31
Samples examined	47,073	52,464	58,477
Physical & Chemical Determinations	60,032	68,591	77,840
Bacteriological Tests	24,750	26,104	28,147

Of interest in the upper third area was the continuation of one auto trailer laboratory at Greensburg, Pennsylvania, where it will continue in operation until the latter part of December, 1940, when it will proceed to Charleston, West Virginia, to work during the month of January, 1941, in the Kenawha Basin. Since the taste and odor study here in the Charleston area, last winter, certain remedial work has been carried out by the industries. It is hoped to measure the effectiveness of this remedial program in reducing objectionable tastes and odors in downstream water supplies.

One trailer unit made special studies along the Clarion River in Pennsylvania for a week's time in October. Preliminary arrangements were made for special studies of taste and odor troubles in the Mahoning Basin to be carried out in November

and December, 1940, with trailer headquarters at Youngstown, Ohio.

In the lower third of the Ohio Basin, there were four mobile laboratories in operation during this fall period. "Unit C" continued operations along the Ohio River, and having finished one complete tour to the mouth of the river, returned to Madison, Indiana, ready for a second trip downstream. A motor boat operates with "Unit C" for the collection of samples in the main stream. "Trailer Units D and E" continued their work along the Wabash and White Rivers in Indiana. "Unit F" was engaged in observations along the Green and Cumberland Rivers in Kentucky.

Special Studies

Owing to the rapid expansion of the training of men in the military preparedness program, a request reached the U. S. Public Health Service in October for information on the character and quality of Ohio River water in the vicinity of the mouth of the Salt River.

Fort Knox faced the necessity of immediately enlarging its public water supply and consideration was given to the possible use of Ohio River as a source of supply. A trailer unit was quickly ordered to this section of the Ohio. Information on the water quality was secured and furnished the Fort Knox officials.

During October, Motorboat #56 and its crew were engaged in a survey of river bottom deposits. These samples were analyzed at the Cincinnati laboratory. Work was carried on in the Louisville, Kentucky, Cincinnati and Gallipolis, Ohio, sections of the main river.

Active work on the acid mine stream study was continued at Morgantown, West Virginia, during September and October. In September, 222 stream samples were collected upon which 1,523 laboratory tests were made. In October, 298 samples were taken and 2,270 tests made on them. This intensive study of one particular stream to ascertain, if possible, the effects of mine sealing will be concluded in December, 1940.

Biological Studies

The field unit completed work in the upper third section of the basin on August 28th. Early in September active operations were started in the Wabash Basin. Plankton samples and net hauls for fish were collected on the Wabash from Peru, Indiana to the mouth and on the White River from Indianapolis. to the junction with the Wabash.

In September 42 fish specimens, and in October 40 fish were shipped to the U. S. Bureau of Fisheries laboratory at Columbia, Missouri, for analysis, through the cooperation of Dr. M. M. Ellis. The summer press of work at the Bureau of Fisheries has delayed examination of these specimens.

COOPERATIVE PROGRAM WITH ENGINEER CORPS

At the request of the Division Engineer, Ohio River Division, memorandum reports are being prepared covering desirable supplemental low flow for pollution control below several proposed reservoir projects on tributaries of the Ohio River. The reports are for use by the District offices on pending reservoirs now under study for report on Survey. They set forth useful and desirable supplemental low flows for pollution abatement and include estimates of tangible monetary benefits that accrue from such regulation.

During October, the request included 21 reservoir projects located in five sub-basins of the Ohio River. It is anticipated that memorandum reports of this type will be developed for all proposed major reservoir projects on streams where additional water is needed during the low flow periods.

On several tributaries, or sections of tributaries, low flow regulation is requisite to practical control of pollution during natural low flow periods. Especially is this true of streams receiving relatively large volumes of sewage or industrial waste in relation to natural low summer flows.

In instances where dilution flows decrease below a one-to-one ratio, continuous peak efficiency of complete treatment works are required for maintenance of even tolerable dissolved oxygen residuals below outfalls. Assurance of such peak efficiencies is often difficult of accomplishment.

In general, the tributaries during extreme low flow periods become a succession of pools and shoals with a concentration of local fish life in the pools. Depletion of dissolved oxygen in such pools located below municipalities may result from sewage treatment effluents or, in certain instances, from natural uncontrolled storm overflows or from a combination of both. Equitable control on certain tributaries combines practical treatment of sewered waste with low flow augmentation from conservation reservoirs.

Flow regulation of streams for pollution control in a critical section has the economic advantage of over-all improvements in general stream uses and often decreases the minimum required treatment for pollution control at less critical points below the reservoir site. Need for pollution control is based on normal stream uses. Economic justification for necessary flow regulation is computed as equal to the minimum annual charges for the supplemental treatment of sewered waste that would maintain equivalent minimum oxygen relations in receiving waters.